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Report of the individual review of the annual submission of Luxembourg submitted in 2013*

* In the symbol for this document, 2013 refers to the year in which the inventory was submitted, and not to the year of publication.

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I. Introduction and summary

1. This report covers the review of the 2013 annual submission of Luxembourg, coordinated by the UNFCCC secretariat, in accordance with decision 22/CMP.1. The review took place from 9 to 14 September 2013 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalists – Ms. Anke Herold (Germany) and Mr. Tinus Pulles (Netherlands); energy – Mr. Ali Can (Turkey), Ms. Rianne Dröge (Netherlands), Mr. Takashi Morimoto (Japan) and Mr. Ioannis Sempos (Greece); industrial processes and solvent and other product use – Mr. Kakhaberi Mdivani (Georgia), Ms. Emilija Poposka (the former Yugoslav Republic of Macedonia) and Mr. Koen Smekens (Belgium); agriculture – Mr. Amnat Chidthaisong (Thailand) and Mr. Steen Gyldenkærne (Denmark); land use, land-use change and forestry (LULUCF) – Mr. Kumeh Assaf (Liberia), Mr. Valentin Bellassen (France) and Mr. Matthew Searson (Australia); and waste – Mr. Gabor Kis-Kovacs (Hungary) and Ms. Sirintornthep Towprayoon (Thailand). Mr. Smekens and Ms. Towprayoon were the lead reviewers. The review was coordinated by Ms. Lisa Hanle (UNFCCC secretariat).

2. In accordance with the "Guidelines for review under Article 8 of the Kyoto Protocol" (decision 22/CMP.1) (hereinafter referred to as the Article 8 review guidelines), a draft version of this report was communicated to the Government of Luxembourg, which made no comment on it. All encouragements and recommendations in this report are for the next annual submission, unless otherwise specified.

3. In 2011, the main greenhouse gas (GHG) in Luxembourg was carbon dioxide (CO_2), accounting for 92.0 per cent of total GHG emissions[1] expressed in CO_2 equivalent (CO_2 eq), followed by nitrous oxide (N_2O) (3.8 per cent) and methane (CH_4) (3.6 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) collectively accounted for 0.6 per cent of the overall GHG emissions in the country. The energy sector accounted for 88.4 per cent of total GHG emissions, followed by the industrial processes sector (5.6 per cent), the agriculture sector (5.5 per cent), the waste sector (0.5 per cent) and the solvent and other product use sector (0.1 per cent). Total GHG emissions amounted to 12,097.92 Gg CO_2 eq and decreased by 6.3 per cent between the base year[2] and 2011. The expert review team (ERT) concludes that the description in the national inventory report (NIR) of the trends for the different gases and sectors is reasonable.

4. Tables 1 and 2 show GHG emissions from sources included in Annex A to the Kyoto Protocol (hereinafter referred to as Annex A sources), emissions and removals from the LULUCF sector under the Convention and emissions and removals from activities under Article 3, paragraph 3, and, if any, elected activities under Article 3, paragraph 4, of the Kyoto Protocol (KP-LULUCF), by gas and by sector and activity, respectively. In table 1, CO_2, CH_4 and N_2O emissions included in the rows under Annex A sources do not include emissions and removals from the LULUCF sector.

5. Additional background data on recalculations by Luxembourg in the 2013 annual submission, as well as information to be included in the compilation and accounting database, can be found in annex I to this report.

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[1] In this report, the term "total GHG emissions" refers to the aggregated national GHG emissions expressed in terms of CO_2 eq excluding LULUCF, unless otherwise specified.

[2] "Base year" refers to the base year under the Kyoto Protocol, which is 1990 for CO_2, CH_4 and N_2O, and 1995 for HFCs, PFCs and SF_6. The base-year emissions include emissions from Annex A sources only.

Table 1

Greenhouse gas emissions from Annex A sources and emissions/removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, by gas, base year[a] to 2011

			Gg CO_2 eq								*Change (%)*
		Greenhouse gas	*Base year[a]*	*1990*	*1995*	*2000*	*2008*	*2009*	*2010*	*2011*	*Base year–2011*
Annex A sources		CO_2	11 950.26	11 950.26	9 210.07	8 780.74	11 209.10	10 704.66	11 255.34	11 125.58	–6.9
		CH_4	461.51	461.51	469.59	467.14	444.81	444.89	452.87	437.00	–5.3
		N_2O	476.11	476.11	480.68	481.37	463.41	467.68	469.83	460.41	–3.3
		HFCs	15.59	12.01	15.59	28.62	63.46	65.54	66.47	67.00	329.8
		PFCs	NA, NO	NA, NO	NA, NO	0.01	0.24	0.22	0.20	0.18	NA
		SF_6	1.55	1.13	1.55	2.15	6.57	7.00	7.39	7.75	398.8
KP-LULUCF	Article 3.3[b]	CO_2					64.16	63.00	46.75	30.49	
		CH_4					NO	NO	NO	NO	
		N_2O					0.37	0.38	0.36	0.35	
	Article 3.4[c]	CO_2	NA				NA	NA	NA	NA	NA
		CH_4	NA				NA	NA	NA	NA	NA
		N_2O	NA				NA	NA	NA	NA	NA

Abbreviations: KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable, NO = not occurring.

[a] "Base year" for Annex A sources refers to the base year under the Kyoto Protocol, which is 1990 for CO_2, CH_4 and N_2O, and 1995 for HFCs, PFCs and SF_6. The base year for cropland management, grazing land management and revegetation under Article 3, paragraph 4, of the Kyoto Protocol is 1990. For activities under Article 3, paragraph 3, of the Kyoto Protocol and forest management under Article 3, paragraph 4, only the inventory years of the commitment period must be reported.

[b] Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation.

[c] Elected activities under Article 3, paragraph 4, of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation.

Table 2
Greenhouse gas emissions by sector and activity, base year[a] to 2011

			Gg CO_2 eq							*Change (%)*
	Sector	*Base year[a]*	*1990*	*1995*	*2000*	*2008*	*2009*	*2010*	*2011*	*Base year–2011*
Annex A	Energy	10 429.93	10 429.93	8 340.89	8 189.11	10 736.99	10 298.52	10 839 35	10 688.67	2.5
	Industrial processes	1 625.50	1 621.50	1 001.64	756.56	705.99	641.57	660.24	671.49	–58.7
	Solvent and other product use	23.90	23.90	19.74	15.81	16.90	16.11	14.34	15.77	–34.0
	Agriculture	743.20	743.20	734.71	721.34	661.28	670 65	677.94	663.65	–10.7
	Waste	82.48	82.48	80.52	77.20	66.44	63.14	60.21	58.33	–29.3
	LULUCF	NA	347.75	–238.10	–385.41	–272.34	–296.43	–295.26	–294.20	NA
	Total (with LULUCF)	**NA**	**13 248.77**	**9 939.39**	**9 374.62**	**11 915.26**	**11 393.55**	**11 956.83**	**11 803.72**	**NA**
	Total (without LULUCF)	**12 905.02**	**12 901.02**	**10 177.48**	**9 760.03**	**12 187.60**	**11 689.99**	**12 252.09**	**12 097.92**	**–6.3**
	Other[b]	NA	NA	NA	NA	NA	NA	NA	NA	NA
KP-LULUCF	Article 3.3[c] Afforestation and reforestation					–76.51	–78.00	–93.80	–109.61	
	Article 3.3[c] Deforestation					141.05	141.38	140.92	140.45	
	Total (3.3)					**65.54**	**63.38**	**47.11**	**30.84**	
	Article 3.4[d] Forest management					NA	NA	NA	NA	
	Article 3.4[d] Cropland management	NA				NA	NA	NA	NA	NA
	Article 3.4[d] Grazing land management	NA				NA	NA	NA	NA	NA
	Article 3.4[d] Revegetation	NA				NA	NA	NA	NA	NA
	Total (3.4)	**NA**				**NA**	**NA**	**NA**	**NA**	**NA**

Abbreviations: KP-LULUCF = LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, LULUCF = land use, land-use change and forestry, NA = not applicable.

[a] "Base year" for Annex A sources refers to the base year under the Kyoto Protocol, which is 1990 for CO_2, CH_4 and N_2O, and 1995 for HFCs, PFCs and SF_6. The base year for cropland management, grazing land management and revegetation under Article 3, paragraph 4, of the Kyoto Protocol is 1990. For activities under Article 3, paragraph 3, of the Kyoto Protocol and forest management under Article 3, paragraph 4, only the inventory years of the commitment period must be reported.

[b] Emissions/removals reported in the sector other (sector 7) are not included in Annex A to the Kyoto Protocol and are therefore not included in national totals.

[c] Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation.

[d] Elected activities under Article 3, paragraph 4, of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation.

II. Technical assessment of the annual submission

A. Overview

1. Annual submission and other sources of information

6. The 2013 annual inventory submission was submitted on 15 April 2013; it contains a complete set of common reporting format (CRF) tables for the period 1990–2011 and an NIR. Luxembourg also submitted the information required under Article 7, paragraph 1, of the Kyoto Protocol, including information on: activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, accounting of Kyoto Protocol units, changes in the national system and in the national registry, and the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol. The standard electronic format (SEF) tables were submitted on 15 April 2013. The Party submitted a revised version of its NIR on 20 May 2013. The annual submission was submitted in accordance with decision 15/CMP.1.

7. Luxembourg did not include any of the annexes to the NIR as suggested by annex I to the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part 1: UNFCCC reporting guidelines on annual inventories" (hereinafter referred to as the UNFCCC reporting guidelines) and the annotated outline of the NIR produced by the secretariat, including some of the reporting elements under the Kyoto Protocol. Some of the information which, according to the annotated outline of the NIR, should be included in the annexes (e.g. the key category analysis and the results of the uncertainty analysis) was not provided in the NIR. With respect to the key category analysis and uncertainty analysis, the Party stated in the NIR that this information was available upon request. The ERT requested this information and used it in its assessment of the Party's 2013 annual submission. For all other subjects that could have been described in the annexes listed in Annex 1 to the UNFCCC reporting guidelines, the ERT used the information as reported in the main text of the NIR and asked for more information or clarification during the review when needed. The ERT recommends that the Party include the annexes to the NIR in the annual submission in order to increase comparability, completeness and transparency of the NIR.

8. The full list of materials used during the review is provided in annex II to this report.

2. Overall assessment of the inventory

9. Table 3 contains the ERT's overall assessment of the annual submission of Luxembourg. For recommendations for improvements related to cross-cutting issues for specific categories, please see the paragraphs cross-referenced in the table.

Table 3
The expert review team's overall assessment of the annual submission

		General findings and recommendations
The expert review team's (ERT's) findings on completeness of the 2013 annual submission		
Annex A sources[a]	Complete	Mandatory: none

		General findings and recommendations
		Non-mandatory: "NE" is reported for potential emissions of HFCs from refrigeration and air-conditioning equipment, foam blowing and aerosols/metered dose inhalers; potential emissions of SF_6 from electrical equipment; CH_4 emissions from enteric fermentation – other (poultry); and CH_4 emissions from direct soil emissions and indirect soil emissions under agricultural soils
Land use, land-use change and forestry[a]	Complete	Mandatory: none
		Non-mandatory: "NE" is reported for the carbon stock changes in living biomass, dead organic matter and soils for wetlands remaining wetlands and settlements remaining settlements; CH_4 and N_2O emissions from settlements; CO_2, CH_4 and N_2O emissions from biomass burning on settlements, and CO_2, CH_4 and N_2O emissions from harvested wood products
KP-LULUCF	Complete	See paragraphs 77 below
The ERT's findings on recalculations and time-series consistency in the 2013 annual submission	Generally consistent	See paragraphs 39, 44 and 63 below for category-specific areas for improvement
The ERT's findings on verification and quality assurance/quality control procedures in the 2013 annual submission	Sufficient	See paragraphs 22, 29, 30, 38, 55, 61 and 65 below for category-specific areas for improvement
The ERT's findings on the transparency of the 2013 annual submission	Generally sufficient	See paragraphs 31 39 40, 41, 44, 53, 58, 60, 66, 75 and 76 below for category-specific areas for improvement

Abbreviations: Annex A sources = sources included in Annex A to the Kyoto Protocol, KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NE = not estimated.

[a] The assessment of completeness by the ERT considers only the completeness of reporting of mandatory categories (i.e. categories for which methods and default emission factors are provided in the Intergovernmental Panel on Climate Change (IPCC) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, or the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*).

3. Description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management

Inventory planning

10. The NIR described the national system for the preparation of the inventory. The Environment Agency of Luxembourg has overall responsibility for the national inventory and compiles the national inventory and implements the quality assurance/quality control

(QA/QC) procedures. The Ministry of Sustainable Development and Infrastructures (MDDI) (Department of the Environment (MDDI-DEV)) acts as the national focal point and is responsible for the official annual submission. Other organizations are also involved in the preparation of the inventory as data providers, such as the National Statistical Institute (STATEC under the Ministry of Economic Affairs and External Trade), the Ministry of Finance (Customs and Excise Agency), the National Society of Technical Control (under MDDI), the Ministry of Internal Affairs and Spatial Planning (Water Management Agency), the Ministry of Agriculture (Agency for Technical Services for Agriculture, Rural Economics Service) and the Nature and Forestry Agency (under MDDI).

11. The previous review report[3] (para.15) encouraged Luxembourg to include an update in the NIR on its efforts to increase staffing for inventory development. This information was not provided in the NIR, but in response to questions raised by the ERT during the review the Party indicated that this remains a high priority but a long term goal, as recruitment is subject to governmental procedures. The previous ERT also encouraged Luxembourg to provide additional information in the NIR regarding its efforts to develop software to support inventory preparation and management. The ERT notes that the discussion regarding the software development process was not updated in the NIR, and, in fact, the 2013 NIR (page 44) still notes that it was intended that the software be completed and used for the 2013 annual submission. The ERT encourages the Party to continue these efforts to support its national system.

Inventory preparation

12. Table 4 contains the ERT's assessment of Luxembourg's inventory preparation process. For improvements related to specific categories, please see the paragraphs cross-referenced in the table.

Table 4
Assessment of inventory preparation by Luxembourg

		General findings and recommendations
Key category analysis		
Was the key category analysis performed in accordance with the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF)?	Yes	Upon request by the ERT, the Party provided the detailed calculation sheets used for the key category analysis. The ERT noted that the organization of these calculation sheets is prone to errors (e.g. no systematic links to workbook cells). However, the ERT did not detect any errors. Nevertheless, the ERT encourages Luxembourg to improve the calculation procedures to minimize the risk of errors and recommends that the Party include the key category analysis as annex I to the NIR of its annual submission (see para. 7 above)
Approach followed?	Tier 1	See paragraph 13 below
Were additional key categories identified using a qualitative	No	

[3] <http://unfccc.int/resource/docs/2013/arr/lux.pdf>.

		General findings and recommendations
approach?		
Has Luxembourg identified key categories for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol following the guidance on establishing the relationship between the activities under the Kyoto Protocol and the associated key categories in the UNFCCC inventory?	Yes	Luxembourg conducted a key category analysis for the LULUCF activities, but as only forest land remaining forest land was identified as a key category, there is no corresponding key category activity under Article 3, paragraph 3, of the Kyoto Protocol (see p. 55 of the NIR)
Does Luxembourg use the key category analysis to prioritize inventory improvements?	Yes	
Are there any changes to the key category analysis in the latest submission?	No	
Assessment of uncertainty analysis		
Approach followed?	Both tier 1 and tier 2	See paragraphs 14 and 15 below
Was the uncertainty analysis carried out in accordance with the IPCC good practice guidance and the IPCC good practice guidance for LULUCF?	Yes	The tier 2 analysis follows the IPCC good practice guidance; however, the tier 1 analysis does not. The data for the percentages below are based on information provided by the Party during the review, performed for 2009 (see paras. 14 and 15 below)
Quantitative uncertainty (including LULUCF)	Level = 4.6% Trend = 3.1%	
Quantitative uncertainty (excluding LULUCF)	Level = 4.1% Trend = 2.0%	

Abbreviations: ERT = expert review team, IPCC = Intergovernmental Panel on Climate Change, LULUCF = land use, land-use change and forestry, NIR = national inventory report.

13. The NIR indicates in tables 1–7 and 1–9 that the inclusion of the LULUCF sector in the key category analysis is "qualitative". In response to a question raised by the ERT during the review, the Party indicated that these table headers are not correct. A tier 1 approach was applied to all sectors, including the LULUCF sector. Luxembourg indicated that this will be corrected, and the ERT recommends that the Party do so.

14. The NIR states that Intergovernmental Panel on Climate Change (IPCC) tier 1 and tier 2 uncertainty analyses have been performed, and that the results of the tier 1 analysis are presented at both a summary level and at the individual category level. The tier 2

analysis is a 2011 study (using 2009 values), referred to in the NIR as "available upon request". The study was sent to the ERT upon request.[4] The aim of the 2011 uncertainty study was to update an earlier study carried out in 2008, and was deemed to be necessary because a number of inventory methods had been changed and major improvements implemented since then. The ERT commends Luxembourg for this thorough and well-performed analysis which also includes a discussion of the effects of the methodological changes on the uncertainties. The tier 2 uncertainty analysis is in line with the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and the ERT concludes that the Party can continue to use the 2011 study to describe the inventory uncertainties and prioritize inventory improvements, as long as major methodological changes are not implemented or significant changes in emissions do not occur in the key categories, compared to the 2011 annual submission.

15. The tier 1 uncertainty analysis was performed using the key categories only. The result of this analysis is a very low uncertainty compared to other reporting Parties. This could be due to the omission of non-key categories that might have relatively high uncertainties. Therefore, table 4 above presents the results of the tier 2 analysis. Since the non-key categories are not included in the tier 1 analysis, the method is not in accordance with the IPCC good practice guidance, as noted in the previous review report. In response to a question raised by the ERT during the review, the Party confirmed that the non-key categories are excluded from the tier 1 key category analysis. This being the case, the ERT recommends that Luxembourg follow either one of two possibilities:

(a) If major methodological improvements have been implemented or significant changes in emissions in one or more key categories have occurred since the tier 2 analysis was conducted, this specific tier 2 analysis can no longer be regarded as properly describing the uncertainties in the inventory. In such a case, the ERT recommends that Luxembourg conduct a full tier 1 or tier 2 analysis to describe and estimate the uncertainties in the inventory for the year in which the significant changes occur and report this information in the NIR;

(b) If major changes in methods or emissions do not occur, the ERT recommends that Luxembourg either perform a tier 1 analysis on an annual basis, but include all categories and sinks in the analysis, or justify in the NIR that the existing tier 2 uncertainty analysis from 2011 is still of sufficient quality to prioritize inventory improvements and was therefore not updated.

16. In any event, the ERT recommends that the Party provide information in the NIR on the uncertainty analysis (e.g. tables 6.1 and 6.2 of the IPCC good practice guidance, and section 5.2.5 of the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF)), consistent with the UNFCCC reporting guidelines (see para. 7 above).

Inventory management

17. Luxembourg has a centralized archiving system, which includes the archiving of disaggregated emission factors (EFs) and activity data (AD), and documentation on how these factors and data have been generated and aggregated for the preparation of the inventory. The archived information also includes internal documentation on QA/QC procedures, external and internal reviews, and documentation on annual key categories and key category identification and planned inventory improvements. Luxembourg archives all

[4] *"Results of the uncertainty analysis to the Luxembourg greenhouse gas inventory (Tier 2 methodology) by individual gas"* (see table 5).

inventory information in a single web-based system called CIRCALUX, which is regularly backed up. All staff members have access to the CIRCALUX system and staff awareness about this communication and archiving tool is periodically refreshed, mostly during QA/QC audits.

4. Follow-up to previous reviews

18. Section 10.4 of Luxembourg's NIR includes a list of planned improvements (table 10-3), partly in response to recommendations made in the previous review reports. The Party also indicated that a prioritization exercise is performed to determine which improvements will be undertaken first. The table does not refer to individual recommendations made in the previous review reports and does not provide information on the prioritization of improvements. In response to a question raised by the ERT during the review, Luxembourg provided this information, including an anticipated timescale for the implementation of the improvements. The ERT recommends that Luxembourg include this information as additional columns in the table on inventory improvements.

5. Areas for further improvement identified by the expert review team

19. During the review, the ERT identified a number of areas for improvement, including some related to specific categories. These are listed in the relevant chapters of this report and in table 8 below.

B. Energy

1. Sector overview

20. The energy sector is the main sector in the GHG inventory of Luxembourg. In 2011, emissions from the energy sector amounted to 10,688.67 Gg CO_2 eq, or 88.4 per cent of total GHG emissions. Since 1990, emissions have increased by 2.5 per cent. Despite the decrease in imports of solid fuels and coal, due to changes in production processes in industry, the increase in the consumption of liquid fuels in transport and the extension of the natural gas network have led to an increase in sectoral emissions. Therefore, the key drivers for the rise in emissions are the categories energy industries, due to strong population growth driven by immigration (emissions have increased by 2,697.5 per cent since 1990) and transport, due to a 75 per cent increase in fuel sales to non-residents (emissions have increased by 151.7 per cent since 1990) These increases were mitigated by a decrease in emissions from manufacturing industries and construction (79.5 per cent). Within the sector, 64.1 per cent of the emissions were from transport, followed by 14.2 per cent from other sectors, 12.1 per cent from manufacturing industries and construction and 9.3 per cent from energy industries. The remaining 0.4 per cent were from fugitive emissions from oil and natural gas.

2. Reference and sectoral approaches

21. Table 5 provides a review of the information reported under the reference approach and the sectoral approach, as well as comparisons with other sources of international data. Issues identified in table 5 are more fully elaborated in paragraphs 22–24 below.

Table 5
Review of reference and sectoral approaches

	Paragraph cross-references
Difference between the reference	Energy consumption:

		Paragraph cross-references
approach and the sectoral approach	1.64 TJ, 0.02% CO_2 emissions: 48.95 Gg CO_2 eq, 0.47%	
Are differences between the reference approach and the sectoral approach adequately explained in the NIR and the CRF tables?	No	See paragraphs 22 and 23 below
Are differences with international statistics adequately explained?	Yes	See paragraph 24 below
Is reporting of bunker fuels in accordance with the UNFCCC reporting guidelines?	Yes	See paragraph 24 below
Is reporting of feedstocks and non-energy use of fuels in accordance with the UNFCCC reporting guidelines?	Yes	

Abbreviations: CRF = common reporting format, NIR = national inventory report, TJ= terajoules, UNFCCC reporting guidelines = "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories".

Comparison of the reference approach with the sectoral approach and international statistics

22. The ERT noted that the overall difference in the estimates of CO_2 emissions between the sectoral and reference approaches is less than 2.0 per cent for the entire time series. The ERT welcomes the improvement from the 2012 annual submission, where the difference between the two approaches was 2.9 per cent for 2010. However, imported lubricants were not included in CRF table 1.A(b) (see para. 30 below), which will cause an increase in CO_2 emissions from the reference approach and affect the differences between the sectoral and reference approaches for liquid fuels. In addition, in the NIR (table 3.13, p. 158), the Party also explained that fuels used in marine activities need to be subtracted from the reference approach where they are still included. The ERT recommends that Luxembourg enter all fuels used in the country in the reference approach estimates and improve its QC procedures prior to submitting the annual submission.

23. Further, the difference in gaseous fuels between the sectoral and reference approaches is 3.9 per cent for 2011. In response to questions raised by the ERT during the review, Luxembourg clarified that there seems to be a discrepancy between the plant-specific data for non-metallic minerals and the energy balance data. The plant-specific data, which are higher than the energy balance data, are used in the inventory, and the Party suggested that this could lead to an overestimation of emissions in the sectoral approach. The Party also indicated that it is planning to provide further quantitative assessment of the differences between the sectoral and reference approaches. The ERT welcomes these efforts, and notes that it is also possible that the plant-specific data may be more accurate than using the energy balance. The ERT recommends that Luxembourg evaluate the possible discrepancy between the two approaches and, if appropriate, clearly explain the differences in the CRF tables and the NIR.

International bunker fuels

24. There is only one airport for commercial aviation in Luxembourg, and all flights coming into that airport are international. Therefore, all jet kerosene is applied to international bunker fuels. Data on fuel consumption for international bunkers are mainly derived from the energy balance, which is compiled and provided by STATEC. As explained on page 156 of the NIR, 10 per cent of aviation gasoline is assumed to be used in international flights, based on expert judgement. The ERT found that the methodology used to split the (bunker) fuel consumption is not clearly explained in the NIR. The ERT strongly reiterates the recommendation made in the previous review report that Luxembourg transparently describe the methodology used to split national and international (bunker) fuel consumption to ensure that civil aviation emissions are accurately estimated. This is particularly important given that CO_2 emissions from international aviation are significant, equalling 11.0 per cent of total national emissions in 2011.

25. Moreover, aviation gasoline used in aviation bunkers and residual oil and gas/diesel oil used in marine bunkers are not included in the International Energy Agency (IEA) data. The amount of jet kerosene used in aviation bunkers is also higher in the CRF tables compared to the IEA data (17,046.39 TJ and 16,985.01 TJ, respectively). In response to questions raised by the ERT during the review, Luxembourg indicated that these discrepancies can be explained by a combination of the relatively low consumption of some fuels in Luxembourg and the precision of the IEA questionnaires, which allow only integer numbers and result in some values being rounded down to zero. The Party also indicated its intent to explain in detail any reporting differences with international organizations and improve the split among international bunkers, civil aviation and navigation. The ERT welcomes these efforts. However, consistent with the previous review report, the ERT encourages the Party to review and, to the extent possible, resolve any outstanding inconsistencies between the data used in the inventory and the IEA figures. Further, the ERT recommends that Luxembourg describe, and if possible quantify, in the NIR any rounding issues in the IEA questionnaires that could result in discrepancies with the CRF tables.

Feedstocks and non-energy use of fuels

26. No problems were identified.

3. Key categories

Stationary combustion: solid and other fuels – CO_2

27. The CO_2 implied emission factor (IEF) for other fuels consumed for public electricity and heat production exhibits a unique trend across the time series: it is stable with a value of 98.98 t/TJ from 1990 to 1997, following which there is a decrease by 6.9 per cent to 92.21 t/TJ in 1998 after which it is stable until 2002. After 2002, the CO_2 IEF ranges from 97.40 t/TJ (2003) to 95.45 t/TJ (2010). The rationale for these observed trends is not well described in the NIR. The ERT recommends that Luxembourg provide additional information in the NIR on the underlying reasons for the change in IEF to ensure time-series consistency.

28. As noted in the previous review report, there are large inter-annual fluctuations in the CO_2 IEF for solid fuels for manufacturing industries and construction, with higher CO_2 IEFs in the 1990s (e.g. 190.87 t/TJ in 1991) and lower CO_2 IEFs in more recent years (as low as 94.75 t/TJ in 2006). In response to recommendations made in the previous review report, the Party has clearly explained the trends in the NIR, attributing the fluctuations to the production process shift in the iron and steel category in the mid-1990s from the use of blast furnaces to the use of electric arc furnaces. The ERT welcomes this improvement in the transparency of the inventory.

Road transportation: liquid fuels – CO_2

29. Luxembourg included CO_2 emissions from lubricants used in road transportation for the first time in the 2012 annual submission. However, the ERT notes that much of the explanation on liquid fuels used in road transportation provided in the NIR still refers to "excluding lubricants" (e.g. the AD, EF, IEF and CO_2 emission calculations in table 3-50 of the NIR). Moreover, on page 205 of the NIR, the Party directs the reader to a reference table for an overview of the CO_2 IEF for lubricants, but the table has not been provided in the corresponding section of the NIR. The ERT recommends that Luxembourg insert this table and include detailed information on lubricant consumption in the tables on road transportation in order to maintain consistency with the CRF tables.

30. According to CRF table 1.A(a), lubricant consumption in road transportation amounted to 175.49 TJ for 2011; however, lubricant consumption has been reported as not occurring ("NO") in CRF table 1.A(b). In response to a question raised by the ERT during the review, Luxembourg noted that the relevant data could not be entered in CRF table 1.A(b) due to the use of an old version of the CRF Reporter software (v3.6.2), but that it would update to the newer version of the CRF Reporter software (v.3.7.3) for the 2014 annual submission. The ERT recommends that Luxembourg update to the newer CRF Reporter software (v.3.7.3) in order to avoid possible inconsistencies between the CRF tables and the NIR, and also recommends that the Party enhance the QC activities prior to submitting the annual submission.

4. Non-key categories

Stationary combustion: liquid fuels – N_2O

31. The N_2O IEF for liquid fuels for 2011 (22.31 kg/TJ) has been identified as the highest among reporting Parties (ranging from 0.19 kg/TJ to 22.31 kg/TJ for 2011) for manufacturing industries and construction. In addition, the N_2O IEF is the highest among reporting Parties for the following subcategories across the entire time series: iron and steel (3.09–24.11 kg/TJ), chemicals (2.25–20.17 kg/TJ), pulp paper and print (13.77–26.10 kg/TJ), food processing, beverages and tobacco (9.17–23.51 kg/TJ) and other (manufacturing industries and construction) (11.17–24.58 kg/TJ). There are also significant inter-annual changes in the N_2O IEF for all of those subcategories, ranging from –55.0 per cent to 74.4 per cent for iron and steel, –31.8 per cent to 98.3 per cent for chemicals, –9.2 per cent to 24.5 per cent for pulp, paper and print, –33.2 per cent to 29.8 per cent for food processing, beverages and tobacco, and –16.5 per cent to 31.9 per cent for other non-specified. In response to questions raised by the ERT during the review, Luxembourg explained that the comparatively high N_2O IEF is due to the use of off-road vehicles under the above-mentioned subcategories. Based on the Party's explanation, the ERT concludes that these subcategories mainly include emissions from off-road vehicles. The ERT considers that the splitting of fuels used for off-road vehicles is necessary in order to improve transparency, and recommends that the Party report emissions from off-road vehicles under the category mobile (other).

Road transportation: liquid fuels – N_2O

32. As noted in the two previous review reports, there are large inter-annual fluctuations in the N_2O IEF for gasoline throughout the time series (ranging from –22.8 per cent to 25.9 per cent) without the provision of clear information on the trend in the NIR. The ERT also found that the N_2O IEF for liquid fuels is still high (2.42 kg/TJ for gasoline 2.84 kg/TJ for diesel oil) when compared with the default EF from the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines) (0.6 kg/TJ for gasoline and diesel oil). In response to questions raised by the ERT during the review of the 2012 annual submission, Luxembourg indicated that a study

was under way to better understand the emissions from road transportation. The ERT reiterates the recommendation made in the previous review report that Luxembourg incorporate the findings from the study in the inventory and report thereon in its NIR.

Other sectors (commercial/institutional): biomass fuels – CO_2

33. The CO_2 IEF for this category is constant at 54.60 t/TJ throughout the time series and has been identified as one of the lowest among reporting Parties for the period 1998–2011 (ranging from 29.60 t/TJ to 122.60 t/TJ) and lower than the IPCC defaults (ranging from 73.33 t/TJ to 112.20 t/TJ). Consistent with the IPCC good practice guidance, CO_2 emissions from biomass should be reported under memo items. Therefore, the ERT recommends that Luxembourg review the constant and comparatively low IEF for biomass and either revise it or provide an explanation in the related sections of the NIR. The ERT also recommends that the Party appropriately report these CO_2 emissions as a memo item.

Oil and natural gas: natural gas – CH_4

34. Luxembourg estimated CH_4 emissions from natural gas transmission and distribution based on total gas consumption (43,218.90 TJ). For natural gas distribution, the CH_4 IEF is 30.09 kg/TJ, resulting in emissions of 1.30 Gg CH_4. According to the NIR, the Party uses the default CH_4 EF from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines) of 1.1 $x10^{-3}$ Gg $CH_4/10^6$ m^3. The ERT notes that using the default CH_4 EF from the Revised 1996 IPCC Guidelines would result in an EF that is 138.5 per cent higher than the EF reported by the Party, while using the default CH_4 EF from the IPCC good practice guidance would result in an EF that is 16.5 per cent higher. In response to questions raised by the ERT during the review, Luxembourg indicated that the EF from the 2006 IPCC Guidelines was selected because the natural gas network in Luxembourg is modern and regularly serviced, both for transmission and distribution and, therefore, that value was determined to be appropriate. The ERT notes this response, and finds that Luxembourg generally uses the 2006 IPCC Guidelines for its energy emission calculations as they are deemed by the Party to be the most appropriate. Nevertheless, the ERT strongly recommends that Luxembourg clearly explain this point in the NIR, providing the country-specific rationale for selecting the EF from the 2006 IPCC Guidelines. If this cannot be provided, the ERT strongly recommends that the Party use the EF from the IPCC good practice guidance.

35. In addition, there was a large inter-annual change in CH_4 emissions from natural gas distribution between 2010 (1.50 Gg CH_4) and 2011 (1.30 Gg CH_4). The 2011 value is 13.3 per cent lower than the 2010 value. The ERT concludes that the information in the NIR suggesting that this was due to the economic crisis may not provide a fully satisfactory explanation as any decrease due to the economic crisis would be partly offset by the increase in demand due to the increasing population. Therefore, the ERT recommends that Luxembourg transparently explain the causes for this decrease in emissions.

C. Industrial processes and solvent and other product use

1. Sector overview

36. In 2011, emissions from the industrial processes sector amounted to 671.49 Gg CO_2 eq, or 5.6 per cent of total GHG emissions, and emissions from the solvent and other product use sector amounted to 15.77 Gg CO_2 eq, or 0.1 per cent of total GHG emissions. Since the base year, emissions have decreased by 58.7 per cent in the industrial processes sector, and decreased by 34.0 per cent in the solvent and other product use sector. The key driver for the fall in emissions in the industrial processes sector is the technological change in the iron and steel production process, specifically the shift from blast furnaces and basic oxygen furnaces to electric arc furnaces. The economic crisis in recent years also

contributed to the decline in emissions. However, emissions increased by 1.7 per cent between 2010 (660.24 Gg CO_2 eq) and 2011. Within the industrial processes sector, 70.4 per cent of the emissions were from mineral products, followed by 18.4 per cent from metal production. The remaining 11.2 per cent were from consumption of halocarbons and SF_6.

37. Luxembourg has addressed some of the recommendations made in the previous review report. In particular, the ERT welcomes the following improvements made:

(a) Providing a complete uncertainty assessment for fluorinated gases (F-gases);

(b) Describing the trend and ensuring a consistent time series for HFC emissions from foam blowing and SF_6 emissions from electrical equipment, in accordance with the IPCC good practice guidance;

(c) Providing a transparent explanation of emissions from soda ash production and use.

2. Key categories

Cement production – CO_2

38. CO_2 emissions from cement production have been estimated using a tier 2 method from the IPCC good practice guidance. According to CRF table 2(I).A–G, a country-specific EF of 0.5338 t CO_2/t clinker produced was used for 2011. This value is not consistent with the EF provided in table 4-5 of the NIR (where an EF of 0.5319 t CO_2/t clinker produced was reported for 2011). The ERT recommends that the Party ensure the consistency of the figures reported.

Iron and steel production – CO_2

39. The previous review report noted that Luxembourg applies different methodologies for different time periods for this category. For electric arc furnace steel production, the 2007 European Union emissions trading system (EU ETS) guidelines[5] were used to estimate emissions for 2004–2010 and a simplified country-specific methodology was used for the years 1990–2003. For a specially designed electric arc furnace (using the PRIMUS process) the 2004 EU ETS guidelines were used for 2005–2009 (the process was shut down in 2009), whereas the emissions for 2003–2004 were estimated based on the relative carbon consumption and the average ratio of the CO_2 emissions per carbon consumption for the years 2005–2008. The CO_2 IEF for the category has decreased from 280.90 kg CO_2/t steel in 1990 to 49.04 kg CO_2/t steel in 2011. The ERT recommends that Luxembourg include an explanation of the variations of the IEF over the time series and include more information on the country-specific methodologies used and how the time-series consistency is maintained in order to increase transparency in the NIR.

Consumption of halocarbons and SF_6 - HFCs, PFCs and SF_6

40. The ERT noted that the Party had not completed the background tables for the category consumption of halocarbons and SF_6. For example, CRF tables 2(I) and 2(II) report emissions from refrigeration and air-conditioning equipment, and noise-reduction windows, while CRF table 2(II).F provides no background data on the estimation of these emissions. The ERT strongly reiterates the recommendation made in the previous review report that Luxembourg improve the consistency and completeness of its reporting. Further,

[5] 2007/589/EC: Commission Decision of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council.

the ERT recommends that the Party enhance the transparency of its reporting of F-gases by providing all of the relevant background information used for the calculations in both the NIR and the CRF tables.

41. During the review, the ERT asked Luxembourg to elaborate on the methods used to estimate SF_6 emissions from electrical equipment. In response to questions raised by the ERT during the review, the Party indicated that it used a tier 2a method from the IPCC good practice guidance for the calculation of SF_6 emissions from electrical equipment. However, the information provided in the NIR is not sufficient to evaluate or verify the Party's response. Therefore, the ERT recommends that Luxembourg provide a more detailed explanation in the NIR of the methodologies and AD used to estimate SF_6 emissions from electrical equipment in order to increase the transparency of its reporting.

42. The ERT notes that Luxembourg continues to use the notation key "NO" to report potential emissions of PFCs from refrigeration and air-conditioning equipment in the CRF tables. The previous review report recommended that the Party replace the notation key "NO" either with a value, or with the notation key "NE" (not estimated), given that it has been demonstrated that actual emissions occur in Luxembourg. As the Party has not yet made the requested correction, the ERT encourages Luxembourg to reconsider the recommendation and replace the notation key "NO" with "NE".

43. The ERT further notes that Luxembourg still uses AD from neighbouring countries for the subcategories under consumption of halocarbons and SF_6 (transport refrigeration, foam blowing and aerosol/metered dose inhalers – from Belgium and Germany). In response to questions raised by the ERT during the review, Luxembourg indicated that this issue is included in its improvement plan. The ERT reiterates the recommendation made in the previous review report that the Party make greater efforts to collect and use country-specific data in the calculation of emissions from consumption of halocarbons and SF_6 to improve the accuracy of its annual submission. Where country-specific data continue to be unavailable, the ERT reiterates the recommendation made in the previous review report that the Party provide the background information used in the calculations in the NIR (e.g. annual population data and per capita emissions of Germany for transport refrigeration, or of Belgium for foam blowing).

3. Non-key categories

Solvent and other product use – N_2O

44. N_2O emissions from anaesthesia have been estimated for the period 1990–2002 by combining emissions data from Germany with the relative population in Luxembourg. For the period 2003–2011, emissions have been estimated using country-specific data collected from hospitals in Luxembourg. In response to questions raised by the ERT during the review regarding Luxembourg's efforts to ensure time-series consistency, the Party responded that it is currently reviewing whether statistical data on the number of surgical operations for the period 1990–2012 are available, and whether a correlation between these data and the use of N_2O in anaesthesia could be found. If successful, then an extrapolation based on surgical operations could be implemented, otherwise an extrapolation based on population would continue to be required. The ERT welcomes the efforts by Luxembourg and reiterates the recommendation made in the previous review report that the Party strive to develop country-specific background data to estimate emissions, and provide transparent background data (whether country-specific or based on another Party) in the NIR. Further, the ERT reiterates the recommendation made in the previous review report that the Party ensure time-series consistency either by using data-specific techniques from the IPCC good practice guidance or by collecting country-specific data for the entire time series.

D. Agriculture

1. Sector overview

45. In 2011, emissions from the agriculture sector amounted to 663.65 Gg CO_2 eq, or 5.5 per cent of total GHG emissions. Since 1990, emissions have decreased by 10.7 per cent. The key drivers for the fall in emissions are the decrease in livestock populations and the decline in the amount of synthetic fertilizer applied to soils. Within the sector, 44.9 per cent of the emissions were from agricultural soils, followed by 36.8 per cent from enteric fermentation and 18.3 per cent from manure management. Rice cultivation and field burning of agricultural residues were reported as "NO".

46. Recommendations made in the previous review reports have not yet been implemented. Specifically, these include the following:

(a) Providing the underlying background information used for the uncertainty calculations in the NIR;

(b) Developing and applying a higher-tier method to estimate CH_4 emissions from manure management for swine, which are significant animals for this category (see para. 50 below);

(c) Addressing inconsistencies in the NIR. For example, for CH_4 emissions from enteric fermentation, the ERT noted an inconsistency between the livestock category labelled "cattle – young cattle – growing heifers" (table 6-4 of the NIR) and the types of animal included in the same category. Luxembourg included male and female young cattle from 1–2 years in the category, while "heifers" refers only to female cattle.

47. The ERT reiterates the recommendation made in previous review reports that Luxembourg address the pending recommendations for this sector and provide information on the implementation of these recommendations in the NIR.

2. Key categories

Manure management – CH_4 and N_2O

48. Luxembourg assumed that 5.0 per cent of the manure for 2011 is digested in biogas plants for all cattle categories and swine. For this amount of manure, a methane conversion factor of 0.0 per cent has been used. The logic provided in the NIR (p. 309) is that the plant is new and gas-tight. The ERT considers that in practical farming, a vast amount of manure is stored beneath the confined animals, primarily on slats. The manure stored under the slats cannot be emptied totally and a certain amount of slurry will always be in the barns and used for flushing. During the storing time, both before and after biogas production, there is a high possibility that CH_4 and N_2O emissions could occur. Such emissions should be quantified and included in the national GHG inventory. In response to questions raised by the ERT during the review, Luxembourg concurred with the ERT's view. Given that CH_4 emissions from manure management is a key category, the ERT recommends that the Party review storage practices, update the methane conversion factor for storage before and after digestion as there are likely emissions before and after the digester, and recalculate CH_4 emissions for all cattle categories and swine for the entire time series. If no data are available, the ERT recommends that the Party estimate emissions from anaerobic digested manure in the same way as the emissions from a liquid/slurry system. The ERT recommends that the emissions estimate be divided into CH_4 emissions on the farm before the treatment in the anaerobic digesters and post-treatment CH_4 emissions from the manure stores according to the equation in the footnote to table 4.10 in the IPCC good practice guidance. In addition, the selected methane conversion factor for pre- and post-treatment should be thoroughly documented with the inclusion of information on stable types and

storage time before the manure is collected, and should also take into account the general declining exponential emissions pattern for the development of CH_4 from organic matter.

49. The nitrogen (N) excretion rates (Nex) for mature dairy cattle are estimated based on the milk yield using a three-step model (85.00 kg N/head/year for a milk yield of less than 5,500 kg/head/year, 93.50 kg N/head/year for a milk yield between 5,500 and 6,500 kg/head/year, and 102.00 kg N/head/year for a milk yield of more than 6,500 kg/head/year). The current milk production provided in CRF table 4.A is 7,220 kg/head/year. The ERT considers that, because it is expected that the amount of Nex is related to milk production, at the current milk production of 7,220 kg/head/year the Nex is expected to be higher than 102.00 kg N/head/year. In response to questions raised by the ERT during the review, Luxembourg agreed with the ERT and mentioned that it will revise the amount of Nex in the next annual submission. The ERT recommends that Luxembourg revise its Nex estimate for dairy cattle in accordance with the milk yield, using an appropriate extrapolation model throughout the time series and recalculate the emissions of N_2O from manure management.

50. Recommendations made in previous review reports included that Luxembourg develop and apply higher-tier methods for the estimation of emissions from swine, which are significant animals for this category. In the 2013 annual submission, the Party has continued to use a tier 1 method. In response to questions raised by the ERT during the review, Luxembourg responded that the implementation of a higher-tier method is planned for the 2014 annual submission, provided that sufficient information on the AD and parameters are available from existing statistics (these are not always available in print or on the Internet) and provided that the data can be analysed by the statistics provider, *Service d'Economie Rurale*. If this is the case, Luxembourg indicated that it will consider moving to a tier 2 method if all necessary data are available back to 1990 to apply the method from the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. The ERT welcomes this intent and reiterates the recommendation made in the previous review report that Luxembourg apply a higher tier for this category.

Agricultural soils – N_2O

51. Luxembourg combined the tier 1, tier 1a and tier 1b methods from the IPCC good practice guidance with the IPCC default EF to estimate N_2O emissions from agricultural soils. As this category is identified as a key category, the ERT reiterates the recommendation made in the previous review report that Luxembourg develop and apply country-specific EFs for this category, including country-specific volatilization fractions ($Frac_{GASM}$ and $Frac_{GASF}$).

E. Land use, land-use change and forestry

1. Sector overview

52. In 2011, net removals from the LULUCF sector amounted to 294.20 Gg CO_2 eq. Since 1990, net emissions have decreased by 184.6 per cent (the sector was a source of net emissions in 1990 (347.75 Gg CO_2 eq) and a source of net removals in 2011). The key driver for the fall in emissions is the ongoing increase in net removals in forest land remaining forest land following the recovery from the major disturbance events in the early 1990s. Within the sector, forest land resulted in net removals (–469.19 Gg CO_2 eq). All other categories resulted in net emissions: the largest source of emissions was from settlements (107.21 Gg CO_2 eq), followed by grassland (31.19 Gg CO_2 eq), cropland (26.56 Gg CO_2 eq), wetlands (9.62 Gg CO_2 eq) and other land (0.41 Gg CO_2 eq).

53. Although references are included in the LULUCF chapter of the NIR, Luxembourg has not provided the full bibliographic information for the citations included in the

LULUCF sector in chapter 16 (References) of the NIR. To support transparency of reporting, the ERT recommends that the Party include the full citations for the literature referenced in the LULUCF sector in chapter 16 of the NIR.

54. Luxembourg reported in the NIR (section 7.1.3) that 91 per cent of the land area is covered by agriculturally used areas and forests and 8 per cent is covered by buildings and roads. The remaining areas are covered by water and other land (1 per cent). This is inconsistent with the underlying data in NIR table 7-6 for 2011, which result in more precise percentages of 89.7 per cent, 9.8 per cent and 0.5 per cent, respectively. The ERT recommends that Luxembourg include the more precise percentages in section 7.1.3 of the NIR.

55. The ERT detected minor inconsistencies between the land-use net emissions/removals reported in NIR tables 7-1 and 7-13 compared with those reported in the CRF tables. For example: total LULUCF net emissions are reported as –294.62 Gg CO_2 eq in table 7-1 of the NIR, but as –294.20 Gg CO_2 eq in CRF table 5; and total cropland emissions are reported as 26.14 Gg CO_2 eq in table 7-13 of the NIR, but as 26.56 Gg CO_2 eq in CRF table 5. The ERT recommends that the Party improve its QC procedures to ensure the consistency of the data reported.

56. Luxembourg made no mention in the NIR of the ground reference used to verify land-use areas. In response to questions raised by the ERT during the review as to how the Party differentiates various species of trees (e.g. spruce, walnut and chestnut trees from other broad leaf trees) with the use of satellite images, Luxembourg explained that special attention is given to ensure the accurate differentiation of various species. The Party stated that the differentiation is relatively clear because, for example, plantations with walnuts or chestnuts do not occur in forest areas, or if they do occur next to forest areas, they are still spatially separated. Where doubts occur, and because of the small size of Luxembourg, some field inspections can easily be undertaken. The ERT accepts the explanation provided by the Party regarding the performance of regular field inspections and recommends that Luxembourg provide information on ground verification exercises in the NIR.

57. In response to general questions raised by the ERT during the review, Luxembourg stated that the results of the second national forest inventory (NFI) conducted in 2010 will be available next year and that there are plans to recalculate the emission/removal estimates from this sector for the 2014 annual submission based on those results. The ERT recommends that Luxembourg use the more accurate results from the second NFI to recalculate the emission/removal estimates from forest land remaining forest land and land converted to forest land.

2. Key categories

Forest land remaining forest land – CO_2

58. Luxembourg used tier 2 methodologies to determine the carbon stock changes in living biomass. The increment in the growing stock biomass, in volume per hectare and year, for all tree types was calculated using yield tables; as no values were provided in the table for beech and oak for the first age class (0–20 years) Luxembourg used average values for the height and diameter measurements to estimate an increment of 87.92 m^3/ha of growth for the first 20 years (equal to an increment of 4.4 m^3/ha/year for beech). The Party reported that there was similarly no value for the age class above 150 years in the yield table; however, Luxembourg estimated growth rates of 8.2 m^3/ha/year and 8.0 m^3/ha/year for 170 years and 190 years, respectively. The ERT notes the higher growth rates for older trees in the categories above 150 years and is concerned that these figures could lead to an overestimation of removals. The ERT reiterates the recommendation made in the previous

review reports that Luxembourg provide transparent documentation on the verification data used to support the growth rates applied.

59. Luxembourg reports emissions from dead organic matter and organic soils as "NO". Previous review reports recommended that Luxembourg collect data on the changes in dead organic matter and soil carbon pools and report thereon in its annual submission in order to improve the accuracy. In response to questions raised by the ERT during review of the 2012 annual submission, Luxembourg indicated that a study could be made at the earliest in 2014; and this intent was reiterated under the planned improvements section in Luxembourg's 2013 NIR. The ERT reiterates the recommendation made in the previous review report that the Party prioritize this work.

60. As noted in the earlier stages of the review, the area of forest land in 2011 reported in the CRF tables is 94 kha compared with the area of 87 kha reported to the Food and Agriculture Organization of the United Nations (FAO). In response to a question raised by the ERT during the review, Luxembourg indicated that this difference needs to be reviewed with the ministry responsible for communicating data to FAO. This is the same response provided by Luxembourg in response to questions raised during previous reviews. The ERT recognizes that there may be reasons for the different areas of forest reported to the different organizations (e.g. because of different definitions), but recommends that the Party transparently discuss in the NIR why such differences may arise.

61. The ERT noted a possible discrepancy in the NIR regarding the soil carbon stock data on forest land on page 354 (0.0 t C/ha) and page 359 (85 t C/ha). In response to a question raised by the ERT during the review, Luxembourg acknowledged that the data on the soil carbon stocks provided in the table on page 354 were misleading because the first row on forest land (which refers to the subcategory forest land remaining forest land) did not belong in a table referring to land-use change. The ERT accepts this explanation and recommends that Luxembourg revise the NIR accordingly.

Land converted to forest land – CO_2, CH_4 and N_2O

62. The Party reported the carbon stock changes in organic soils and dead wood as "NO" using the IPCC good practice guidance tier 1 method which assumes no changes in these pools. Luxembourg reported that, in the case of dead wood, no data are available between two time points, which will be corrected once the second NFI is completed. The ERT recommends that the Party prioritize this work.

Land converted to settlements – CO_2

63. The trend in CO_2 emissions in this subcategory appears to be inconsistent across the time series. The emissions are constant during the period 1990–1999 (138.93 Gg CO_2) and then decline in 2000 to 118.35 Gg CO_2 (a 14.8 per cent decrease), followed by a downward trend that remains constant at 0.9 per cent per year to 2011 (107.21 Gg CO_2). In response to questions raised by the ERT during the review regarding this large inter-annual change between 1999 and 2000, Luxembourg explained that the change is due to the fact that the land-use change trends are calculated based on land-use maps for the years 1989, 1999 and 2007. Hence, between 1989 and 1999, as well as between 1999 and 2007, the land use is linearly interpolated (NIR, p. 347, table 7-6). Luxembourg indicated that for the period 2008–2012, the land use will be re-evaluated with new land use data from 2012. The ERT recommends that the Party implement this improvement, as planned.

3. Non-key categories

Cropland remaining cropland – CO_2

64. During the review, the ERT noted that there was a large inter-annual variation in emissions between 2010 (6.72 Gg CO_2 eq) and 2011 (5.53 Gg CO_2 eq) (a decrease in

emissions of 17.7 per cent). Between 1990 (–5.98 Gg CO_2 eq) and 2011 net emissions increased by 192.5 per cent. The trend in emissions is relatively stable from 1990 to 1999 (–5.44 Gg CO_2 eq) before increasing to 16.35 Gg CO_2 eq in 2000 (a 400.7 per cent increase). In response to questions raised during the earlier stages of the review, Luxembourg indicated that the trends reflected the change in land areas as well as the 30-year management cycle for perennial cropland. The ERT accepts Luxembourg's response but recommends that the Party elaborate on a discussion of the trends in the NIR.

65. In reviewing the trends discussed in paragraph 64 above, the ERT noted that there were inconsistencies between the NIR and CRF table 5.B. For example, for 20[illegible], CRF table 5.B. indicates that net CO_2 emissions from this category were equal to 1.35 Gg CO_2; however, table 7–13 in the NIR reports 0.92 Gg CO_2. These differences persist for the time series. The ERT recommends that the Party correct the error in the NIR and review its QC procedures prior to the annual submission.

Settlements converted to other land uses– CO_2

66. In the NIR, Luxembourg reported that biomass losses on areas of settlements converted to other land uses were estimated to be equivalent to 20 years of tree and shrub growth on these lands. In response to questions raised by the ERT during the review to clarify the rationale for the use of the 20-year growth period (because at 20 years trees are comparatively small), Luxembourg explained that the rationale was that settlement areas with an equal distribution of older and younger biomass stocks are converted. Therefore, from a range of settlement areas with biomass stocks representing 1 year to 40 years of growth that are converted, the biomass stock from this range of land-use change areas is the average one of 20 years. The ERT recommends that Luxembourg provide this detailed description of its rationale for the use of the 20-year method in its NIR.

F. Waste

1. Sector overview

67. In 2011, emissions from the waste sector amounted to 58.33 Gg CO_2 eq, or 0.5 per cent of total GHG emissions. Since 1990, emissions have decreased by 29.3 per cent. The key drivers for the fall in emissions are the decline in the quantity of waste being landfilled, notably through the development of recycling schemes and the expansion of the various waste categories collected by recycling centres, aerobic pre-treatment before landfilling and the recent installation of CH_4 recovery systems at landfill sites. Within the sector, 50.6 per cent of the emissions were from solid waste disposal on land, followed by 26.1 per cent from the category other (waste) and 23.3 per cent from wastewater handling.

68. The ERT welcomes the improvements made by the Party in response to the recommendations made in previous review reports, particularly the provision of additional information on the share of aerobic and anaerobic treatment of sludge from domestic and commercial wastewater treatment in the CRF tables.

2. Non-key categories

Solid waste disposal on land – CH_4

69. The calculation of the emission estimates takes into account the emissions from pre-treatment of solid waste prior to landfilling, starting from 1993. The emissions are estimated according to the share of waste sent to landfills and pre-treatment. In response to the recommendations made in the previous review report, Luxembourg has included in the NIR an explanation for the use of a methane conversion factor (MCF) of 0.1 for mechanical-biological treatment (MBT). According to Luxembourg, the low MCF can be

explained by the fact that up to 95 per cent less CH_4 is produced with MBT than with untreated waste in solid waste disposal sites (SWDS) (vol. 5, p. 4.4 of the 2006 IPCC Guidelines). Based on the information provided in the NIR, the ERT accepts that there is no underestimate of emissions taking place with the use of an MCF of 0.1. However, the ERT considers that MBT is biological treatment, as categorized in chapter 4 of the 2006 IPCC Guidelines, and should not be classified as an uncategorized landfill. During the review, the ERT asked the Party to explain the conditions and system of MBT implemented in Luxembourg. In response to the questions raised by the ERT during the review, the Party agreed that MBT should not be classified as an uncategorized landfill, but indicated that there is no clear place for reporting these emissions in the CRF tables. The ERT concludes that the system of MBT is biological treatment, which produces emissions and should not be classified as uncategorized SWDS and therefore recommends that Luxembourg allocate emissions from MBT to other (waste) for the year 1993 onwards.

70. Recommendations made in previous review reports included that Luxembourg revise the CH_4 recovery from solid waste disposal on land for 2000, for which a value from 2001 was used (0.15 Gg CH_4). Luxembourg has not revised the value in the 2013 annual submission. Therefore, the ERT reiterates the recommendation made in the previous review report that, consistent with the IPCC good practice guidance, the Party use monitoring data to report CH_4 recovery or assume that no recovery occurs.

Wastewater handling – CH_4 and N_2O

71. The Party used the IPCC tier 1 method with country-specific and default EFs to estimate CH_4 and N_2O emissions from wastewater handling. CH_4 emissions from industrial wastewater treatment are reported as "NO" due to the fact that there are no anaerobic treatment plants for industrial wastewater (100 per cent aerobic treatment) in the country. Luxembourg has estimated N_2O emissions from industrial wastewater treatment plants from 2002 onwards based on data availability. CH_4 and N_2O emissions from domestic and commercial wastewater and septic tanks have been estimated for the entire time series. Emissions from sludge residue are accounted for under other (waste) and the agriculture sector. As noted in the previous review report, Luxembourg indicated that part of the sludge is applied to agricultural soils and that the N_2O emissions are reported under the category agricultural soils, while other parts are incinerated with energy recovery and the emissions are therefore reported in the energy sector under other (manufacturing industries and construction). The remainder of the sludge is composted and the CH_4 and N_2O emissions are therefore reported under the category other (waste). The previous review report encouraged the Party to expand the explanation on the sludge use by including information on the amount of sludge and on the distribution of the above-mentioned treatment methods in the NIR. As the Party has not provided additional information on sludge in the 2013 NIR, the ERT reiterates this encouragement.

72. Luxembourg is planning to improve its list of wastewater treatment plants that use recovered CH_4 as the energy source and is also planning to implement the results of a new census conducted in 2011 in the 2014 annual submission. The ERT welcomes these improvements.

G. Supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

1. Information on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol

Overview

73. Table 6 provides an overview of the information reported and parameters selected by Luxembourg under Article 3, paragraphs 3 and 4, of the Kyoto Protocol.

Table 6
Supplementary information reported under Article 3, paragraphs 3 and 4, of the Kyoto Protocol

		Findings and recommendations
Has Luxembourg reported information in accordance with the requirements in paragraphs 5–9 of the annex to decision 15/CMP.1?	Sufficient	77
Identify any elected activities under Article 3, paragraph 4, of the Kyoto Protocol	Activities elected: none Years reported: none	
Identify the period of accounting	Commitment period accounting"	
Assessment of Luxembourg's ability to identify areas of land and areas of land-use change	Sufficient	75

74. In response to a recommendation made in the previous review report, Luxembourg has clarified in its NIR that the methods used to estimate soil carbon stock changes for afforestation, reforestation and deforestation activities are based on the IPCC tier 1 method. The ERT commends Luxembourg for clarifying this issue.

75. Previous review reports identified an issue for Luxembourg regarding the provision of transparent information on the exact methodology and assumptions used to obtain the areas of land subject to afforestation, reforestation and deforestation and recommended that Luxembourg transparently include this information in the next annual submission. In the NIR for 2013, Luxembourg has provided a description of the method used to identify areas subject to activities under Article 3, paragraph 3, of the Kyoto Protocol in the period 1989–2007 but has not provided such information for the period 2008–2011. The ERT recommends that Luxembourg transparently include information on the method used to identify land subject to activities under Article 3, paragraph 3, of the Kyoto Protocol from 1990 to the current inventory year.

Activities under Article 3, paragraph 3, of the Kyoto Protocol

Afforestation and reforestation – CO_2

76. The ERT notes that Luxembourg reported the below-ground living biomass pool as included elsewhere ("IE") in the CRF tables. On page 441 of the NIR, the Party explained that "the carbon stock in the below ground biomass is considered as included in the above ground biomass jointly". The IPCC good practice guidance for LULUCF states the following regarding the reporting of pools: The Marrakesh Accords[6] specify that carbon

[6] FCCC/CP/2001/13/Add.1.

stock changes in five pools must be reported: above-ground biomass, below-ground biomass, dead wood, litter and soil organic carbon. The ERT strongly recommends that Luxembourg improve the transparency of its reporting under the Kyoto Protocol and separately report the carbon stock changes for the living biomass pools (above-ground and below-ground) using the information already available within its national inventory system.

77. Luxembourg reported dead wood as "NO" in afforestation/reforestation areas for 1990 onwards. However, the ERT notes a massive disturbance in Luxembourg's forests in the early 1990s (as described in the NIR, p. 337) that could have redistributed carbon between the different pools (dead wood and litter). In response to questions raised by the ERT during the review as to whether additional verifiable proof is available for the 2013 annual submission that the dead wood pool is not a net source, Luxembourg made reference to its second NFI which contains verifiable information from further field studies that carbon stock changes do not occur in dead wood. In order to ensure transparency in its reporting, the ERT recommends that Luxembourg provide this information, using data from the second NFI, as appropriate, in the NIR to demonstrate that this pool is not a net source.

78. The ERT notes that Luxembourg has not provided an uncertainty analysis for activities under Article 3, paragraph 3, of the Kyoto Protocol. In response to questions raised by the ERT during the review, Luxembourg stated that an uncertainty assessment of emissions/removals will be completed for the 2014 annual submission The ERT recommends that the Party transparently report the results of the uncertainty analysis in the NIR.

Deforestation – CO_2 and N_2O

79. The trend in emissions from deforestation areas has been nearly constant since 2008. In 2011, emissions from deforestation amounted to 140.45 Gg CO_2 eq. Luxembourg reported in CRF table 5(KP-I)A.2 that about 90 per cent of emissions were due to biomass losses, and 10 per cent due to carbon stock losses in dead wood and soil. The ERT recommends that the Party separately report the below-ground and above-ground living biomass pools (see para. 76 above) as this is a requirement specified in the Marrakesh Accords.

80. The ERT commends Luxembourg for correcting the calculation for N_2O emissions from disturbance associated with land-use conversion to cropland to reflect the country-specific carbon/nitrogen ratio. As included in the recommendations made in the previous review reports.

2. Information on Kyoto Protocol units

Standard electronic format and reports from the national registry

81. Luxembourg has reported information on its accounting of Kyoto Protocol units in the required SEF tables, as required by decisions 15/CMP.1 and 14/CMP.1. The ERT took note of the findings included in the standard independent assessment report (SIAR) on the SEF tables and the SEF comparison report.[7] The SIAR was forwarded to the ERT prior to the review, pursuant to decision 16/CP.10. The ERT reiterated the main findings and recommendations contained in the SIAR (see para. 87 below).

82. Information on the accounting of Kyoto Protocol units has been prepared and reported in accordance with decision 15/CMP.1, annex, chapter I.E, and reported in

[7] The SEF comparison report is prepared by the international transaction log (ITL) administrator and provides information on the outcome of the comparison of data contained in the Party's SEF tables with corresponding records contained in the ITL.

accordance with decision 14/CMP.1 using the SEF tables. This information is consistent with that contained in the national registry and with the records of the international transaction log (ITL) and the clean development mechanism registry and meets the requirements referred to in decision 22/CMP.1, annex, paragraph 88(a–j). The transactions of Kyoto Protocol units initiated by the national registry are in accordance with the requirements of the annex to decision 5/CMP.1 and the annex to decision 13/CMP.1. No discrepancy has been identified by the ITL and no non-replacement has occurred. The national registry has adequate procedures in place to minimize discrepancies.

Calculation of the commitment period reserve

83. Luxembourg has reported its commitment period reserve in its 2013 annual submission. Luxembourg reported that its commitment period reserve has not changed since the initial report review (42,662,696 t CO_2 eq), as it is based on the assigned amount and not on the most recently reviewed inventory. The ERT agrees with this figure.

Changes to the national system

84. Luxembourg reported that there are no changes in its national system since the previous annual submission. The ERT concluded that the Party's national system continues to be in accordance with the requirements of national systems outlined in decision 19/CMP.1.

3. Changes to the national registry

85. Luxembourg reported that there are changes in its national registry since the previous annual submission. The Party described the changes, specifically due to the centralization of the EU ETS operations into a single European Union (EU) registry operated by the European Commission called the Consolidated System of European Union Registries (CSEUR), in its NIR (see p. 451 et seq.). CSEUR is a consolidated platform which implements the national registries in a consolidated manner and was developed together with the new EU registry.

86. The ERT noted that there were recommendations in the SIAR that had not been addressed related to CSEUR, in particular recommendations related to reporting a description of the changes in the database structure and the reporting of test results. In response to questions raised by the ERT during the review, Luxembourg provided further information on the changes to the national registry, including on the changes in the database structure and the reporting of test results.

87. The ERT concluded that, taking into account the confirmed changes in the national registry, including additional information provided to the ERT during the review, Luxembourg's national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1 and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol. With respect to the provision of information related to the database structure specifically, the ERT encourages the Party to provide additional information in the NIR. The ERT recommends that Luxembourg include all other additional information in response to the SIAR findings in its NIR in accordance with decision 15/CMP.1, annex, chapter I.G.

4. Minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol

88. Luxembourg did not provide information on changes in its reporting of the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol in its annual submission. However, in response to questions raised by the ERT during the review, the Party confirmed that changes in its reporting under Article 3, paragraph 14 had not occurred and indicated that this information will be explicitly included in the next annual submission. The ERT reiterates the recommendation made in the previous review report that the Party explicitly report whether or not change(s) in its information provided under Article 3, paragraph 14, of the Kyoto Protocol have occurred.

89. Luxembourg reported detailed information on how it responds to each of the subparagraphs under paragraph 24 of the annex to decision 15/CMP.1, listing the individual measures taken for each subparagraph. In particular, Luxembourg emphasized the measures taken regarding progressive reduction and phasing out of market imperfections, fiscal incentives and subsidies.

III. Conclusions and recommendations

A. Conclusions

90. Table 7 summarizes the ERT's conclusions on the 2013 annual submission of Luxembourg, in accordance with the Article 8 review guidelines.

Table 7
Expert review team's conclusions on the 2013 annual submission of Luxembourg

		Paragraph cross-references
The ERT concludes that the inventory submission of Luxembourg is complete (categories, gases, years and geographical boundaries and contains both an NIR and CRF tables for 1990–2011)		
Annex A sources[a]	Complete	
LULUCF[a]	Complete	
KP-LULUCF	Complete	77
The ERT concludes that the inventory submission of Luxembourg has been prepared and reported in accordance with the UNFCCC reporting guidelines	Yes	7, 16
The submission of information required under Article 7, paragraph 1, of the Kyoto Protocol has been prepared and reported in accordance with decision 15/CMP.1	Yes	87, 88
Luxembourg's inventory is in accordance with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*	Yes	
Luxembourg has reported information on Article 3, paragraphs 3 and 4,	Yes	76, 77

		Paragraph cross-references
of the Kyoto Protocol		
Luxembourg has reported information on its accounting of Kyoto Protocol units in accordance with decision 15/CMP.1, annex, chapter I.E, and used the required reporting format tables as specified by decision 14/CMP.1	Yes	
The national system continues to perform its required functions as set out in the annex to decision 19/CMP.1	Yes	
The national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1 and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant CMP decisions	Yes	87
Did Luxembourg provide information in the NIR on changes in its reporting of the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol?	No	88

Abbreviations: Annex A sources = sources included in Annex A to the Kyoto Protocol, CMP = Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, CRF = common reporting format, ERT = expert review team, IPCC = Intergovernmental Panel on Climate Change, KP-LULUCF = LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, LULUCF = land use, land-use change and forestry, NIR = national inventory report, UNFCCC reporting guidelines = "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories".

[a] The assessment of completeness by the ERT considers only the completeness of reporting of mandatory categories (i.e. categories for which methods and default emission factors are provided in the Intergovernmental Panel on Climate Change (IPCC) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, or the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*).

B. Recommendations

91. The ERT identified the issues for improvement listed in table 8. All recommendations are for the next annual submission, unless otherwise specified.

Table 8
Recommendations identified by the expert review team

Sector	*Category*	*Recommendation*	*Paragraph reference*
Cross-cutting	Annual submission and other sources of information	Include the uncertainty and key category (and all other) annexes in the annual submission	7, Table 4
		Correct the reference in the NIR which indicates that the key category analysis for the land use, land-use change and forestry sector is "qualitative"	13
		If major methodological improvements have been implemented or significant changes in emissions in one or more key categories have occurred, conduct a full tier 1 or tier 2 analysis to describe and estimate the uncertainties in	15

Sector	*Category*	*Recommendation*	*Paragraph reference*
		the inventory or for the year in which the significant changes in emissions occur and report this information in the NIR. Or, if major changes in methods or emissions do not occur, either perform a tier 1 analysis on an annual basis, but include all categories and sinks in the analysis, or provide justification in the NIR that the existing tier 2 uncertainty analysis from 2011 is still of sufficient quality	
		Provide information in the NIR on the uncertainty analysis	16
	Follow up to previous reviews	Include additional columns in table 10-3 of the NIR on inventory improvements to include individual recommendations made in previous review reports, the prioritization of improvements and the anticipated time scale for implementation	18
Energy	Comparison of the reference approach with the sectoral approach and international statistics	Enter all fuels used in the country in the reference approach estimates and improve QC procedures prior to submitting the annual submission	22
		Evaluate the possible discrepancy between the sectoral and reference approaches for gaseous fuels and, if appropriate, clearly explain the differences in the CRF tables and the NIR	23
	International bunker fuels	Transparently describe the methodology used to split national and international (bunker) fuel consumption to ensure, in particular, that civil aviation emissions are accurately estimated	24
		Describe, and if possible quantify, in the NIR any rounding issues in the IEA questionnaires that could result in discrepancies with the CRF tables	25
	Stationary combustion: solid and other fuels – CO_2	Provide additional information in the NIR on the underlying reasons for the change in the IEF for other fuels consumed for public electricity and heat production	27
	Road transportation: liquid fuels – CO_2	Insert the reference table for an overview of the CO_2 IEF for lubricants and include detailed information on lubricant consumption in the tables on road transportation	29
		Update to the newer CRF Reporter software (v.3.7.3) in order to avoid possible inconsistencies between the CRF tables and the NIR and enhance QC activities prior to submission	30
	Stationary combustion:	Report emissions from off-road vehicles under the category	31

Sector	*Category*	*Recommendation*	*Paragraph reference*
	liquid fuels – N_2O	mobile (other)	
	Road transportation: liquid fuels– N_2O	Incorporate the findings from the study that aims to better understand emissions from road transportation in the inventory and report thereon	32
	Other sectors: biomass fuels – CO_2	Review the constant and comparatively low IEF for biomass and either revise it or provide an explanation in the related sections of the NIR	33
		Appropriately report CO_2 emissions as a memo item	33
	Oil and natural gas: natural gas – CH_4	Provide the country-specific rationale for selecting the EF from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* or if this cannot be provided, use the EF from the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*	34
		Transparently explain the causes for the decrease in CH_4 emissions from natural gas distribution between 2010 and 2011	35
Industrial processes and solvent and other product use	Cement production – CO_2	Ensure the consistency of reporting between the NIR and the CRF tables for the EF for clinker	38
	Iron and steel production – CO_2	Include an explanation of the variations of the IEF for steel production over the time series, include more information on the country-specific methodologies and how the time-series consistency is maintained	39
	Consumption of halocarbons and SF_6 – HFCs, PFCs and SF_6	Improve the consistency and completeness of reporting of the emissions and background data in CRF table 2(II)F and enhance transparency by providing all of the relevant background information used for calculations in both the NIR and the CRF tables	40
		Provide a more detailed explanation in the NIR of the methodologies and AD used to estimate SF_6 emissions from electrical equipment	41
		Make greater efforts to collect and use country-specific data in the calculation of emissions from consumption of halocarbons and SF_6	43
		Where country-specific data continue to be unavailable, provide the background information used in the calculations in the NIR (e.g. annual population data and per capita emissions of Germany for transport refrigeration, or of Belgium for foam blowing)	43
	Solvent and	Strive to develop country-specific background data to	44

Sector	*Category*	*Recommendation*	*Paragraph reference*
	other product use – N_2O	estimate emissions from N_2O from anaesthesia, and provide transparent background data (whether country-specific or based on another Party)	
		Ensure time-series consistency for N_2O emissions from anaesthesia either by using data-specific techniques from the IPCC good practice guidance or by collecting country-specific data for the entire time series	44
Agriculture	Sector overview	Address the pending recommendations for this sector and provide information on the implementation of these recommendations in the NIR	47
	Manure management – CH_4 and N_2O	Review storage practices and update the methane conversion factor for storage before and after digestion and recalculate CH_4 emissions from anaerobic digesters for all cattle categories and swine for the entire time series. If no data are available estimate emissions from anaerobic digested manure in the same way as the emissions from a liquid/slurry system	48
		Divide CH_4 emissions into emissions on the farm before the treatment in the anaerobic digesters and post-treatment CH_4 emissions from the manure stores according to the equation in the footnote to table 4.10 in the IPCC good practice guidance	
		Document the selected methane conversion factor for pre- and post-treatment thoroughly with inclusion of information on stable types and storage time before the manure is collected and taking into account the general declining exponential emissions pattern for the development of CH_4 from organic matter	48
		Apply a higher tier for estimation of emissions from swine	50
	Agricultural soils – N_2O	Develop and apply country-specific EFs for this category, including country specific volatilization fractions ($Frac_{GASM}$ and $Frac_{GASF}$)	51
LULUCF	Sector overview	Include the full citations for the literature referenced in the LULUCF sector in chapter 16 of the NIR	53
		Include the more precise percentages in section 7.1.3 of the NIR	54
		Improve QC procedures to ensure the consistency of the data reported	55
		Provide information on ground verification exercises in the NIR	56
		Use the more accurate results from the second National Forest Inventory (NFI) to recalculate the emission/removal	57

Sector	*Category*	*Recommendation*	*Paragraph reference*
		estimates from forest land remaining forest land and land converted to forest land	
	Forest land remaining forest land – CO_2	Provide transparent documentation on the verification data used to support the growth rates applied	58
		Prioritize work to collect data on the changes in dead organic matter and soil carbon pools	59
		Provide in the NIR the rationale for differences between data reported in the CRF tables and data reported to the Food and Agriculture Organization of the United Nations (FAO)	60
		Clarify reporting of information regarding the soil carbon stock data on forest land on pages 354 and 359 of the NIR	61
	Land converted to forest land – CO_2	Prioritize data analysis from the second NFI to analyse carbon stock change in organic soils and dead wood	62
	Land converted to forest settlements – CO_2	Implement the Party's stated intent to re-evaluate the land use with new land use data from 2012, for the period 2008–2012	63
	Cropland remaining cropland – CO_2	Elaborate on the discussion of trends in the NIR	64
		Correct inconsistencies between the NIR and CRF table 5.B. regarding reporting of net CO_2 emissions	65
	Settlements converted to other land uses – CO_2	Provide a detailed description of the rationale for the use of the 20-year method in its NIR	66
Waste	Solid waste disposal on land – CH_4	Allocate emissions from mechanical biological treatment to other (waste) for the year 1993 onwards	69
		Use monitoring data to report CH_4 recovery for 2000 or assume that no recovery occurs	70
KP-LULUCF	Sector overview	Include information on the method used to identify land subject to activities under Article 3, paragraph 3, of the Kyoto Protocol from 1990 to the current inventory year	75
	Afforestation and reforestation – CO_2	Improve the transparency of reporting under the Kyoto Protocol and separately report the carbon stock changes for the living biomass pools (above-ground and below-ground) using the information already available within the national	76

Sector	*Category*	*Recommendation*	*Paragraph reference*
		inventory system	
		Provide information from the second NFI, as appropriate, to demonstrate that the dead wood pool is not a net source	77
		Transparently report the results of the uncertainty analysis in the NIR	78
	Deforestation – CO_2	Separately report the below-ground and above-ground living biomass pools	79
Changes to the national registry		Include all other additional information in response to the SIAR findings in its NIR in accordance with decision 15/CMP.1, annex, chapter I.G	87
Article 3, paragraph 14, of the Kyoto Protocol		Explicitly report whether or not change there are changes in information provided under Article 3, paragraph 14, of the Kyoto Protocol have occurred	88

Abbreviations: AD = activity data, CMP = Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, CRF = common reporting format, EF = emission factor, FAO = Food and Agriculture Organization of the United Nations, IEA = International Energy Agency, IEF = implied emission factor, IPCC = Intergovernmental Panel on Climate Change, KP-LULUCF = LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, LULUCF = land use, land use change and forestry, NFI = National Forest Inventory, NIR = national inventory report, QC = quality control, SIAR = standard independent assessment report.

IV. Questions of implementation

92. No questions of implementation were identified by the ERT during the review.

Annex I

Background data on recalculations and information to be included in the compilation and accounting database

Table 9
Recalculations in the 2013 annual submission for the base year and the most recent year

	1990	*2010*	*1990*	*2010*	
Greenhouse gas source and sink categories	*Value of recalculation (Gg CO_2 eq)*		*Per cent change*		*Reason for the recalculation*
1. Energy	60.23	187.16	0.6	1.8	Changed AD and EF
A. Fuel combustion (sectoral approach)	60.23	187.16	0.6	1.8	
1. Energy industries		–63.56	0.6	–5.0	
2. Manufacturing industries and construction	–1.27	36.90		2.6	
3. Transport	61.50	95.14	0.0	1.5	
4. Other sectors		118.68		7.2	
5. Other					
B. Fugitive emissions from fuels					
1. Solid fuels					
2. Oil and natural gas					
2. Industrial processes					
A. Mineral products					
B. Chemical industry					
C. Metal production					
D. Other production					
E. Production of halocarbons and SF6					
F. Consumption of halocarbons and SF6					
G. Other					
3. Solvent and other product use					
4. Agriculture	–2.67	–12.31	–0.4	–1.8	Changed AD and EF
A. Enteric fermentation		–0.45		–0.2	
B. Manure management	–0.93	–1.33	–0.8	–1.1	
C. Rice cultivation					
D. Agricultural soils	–1.74	–10.52	–0.5	–3.3	
E. Prescribed burning of savannas					
F. Field burning of agricultural residues					
G. Other					

Greenhouse gas source and sink categories	*1990*	*2010*	*1990*	*2010*	*Reason for the recalculation*
	Value of recalculation (Gg CO_2 eq)		*Per cent change*		
5. Land use, land-use change and forestry		0.11		0.0	Changed AD
A. Forest land					
B. Cropland		0.11		0.4	
C. Grassland					
D. Wetlands					
E. Settlements					
F. Other land					
G. Other					
6. Waste	–7.46	–3.75	–8.3	–5.9	Changed AD and EF
A. Solid waste disposal on land	–7.46	–3.46	–10.0	–10.0	
B. Wastewater handling					
C. Waste incineration					
D. Other		–0.29		–1.9	
7. Other					
Total CO_2 equivalent without LULUCF	**50.10**	**171.10**	**0.4**	**1.4**	
Total CO_2 equivalent with LULUCF	**50.10**	**171.21**	**0.4**	**1.5**	

Abbreviations: AD = activity data, EF = emission factor, LULUCF = land use, land-use change and forestry.

Table 10
Information to be included in the compilation and accounting database in t CO_2 eq for 2011, including the commitment period reserve

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Commitment period reserve	42 662 696			42 662 696
Annex A emissions for 2011				
CO_2	11 125 581			11 125 581
CH_4	436 996			436 996
N_2O	460 408			460 408
HFCs	66 996			66 996
PFCs	180			180
SF_6	7 754			7 754
Total Annex A sources	**12 097 915**			**12 097 915**
Activities under Article 3, paragraph 3, for 2011				
3.3 Afforestation and reforestation on non-harvested land for 2011	−109 614			−109 614
3.3 Afforestation and reforestation on harvested land for 2011	NO			NO
3.3 Deforestation for 2011	140 451			140 451
Activities under Article 3, paragraph 4, for 2011[c]				
3.4 Forest management for 2011				
3.4 Cropland management for 2011				
3.4 Cropland management for the base year				
3.4 Grazing land management for 2011				
3.4 Grazing land management for the base year				
3.4 Revegetation for 2011				
3.4 Revegetation in the base year				

Abbreviation: NO = not occurring.
[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustment(s).
[b] "Final" includes revised estimates, if any, and/or adjustments, if any.
[c] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Table 11
Information to be included in the compilation and accounting database in t CO_2 eq for 2010

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Annex A emissions for 2010				
CO_2	11 255 343			11 255 343
CH_4	452 866			452 866
N_2O	469 825			469 825
HFCs	66 471			66 471
PFCs	198			198
SF_6	7 390			7 390
Total Annex A sources	**12 252 093**			**12 252 093**
Activities under Article 3, paragraph 3, for 2010				
3.3 Afforestation and reforestation on non-harvested land for 2010	–93 805			–93 805
3.3 Afforestation and reforestation on harvested land for 2010	NO			NO
3.3 Deforestation for 2010	140 916			140 916
Activities under Article 3, paragraph 4, for 2010[c]				
3.4 Forest management for 2010				
3.4 Cropland management for 2010				
3.4 Cropland management for the base year				
3.4 Grazing land management for 2010				
3.4 Grazing land management for the base year				
3.4 Revegetation for 2010				
3.4 Revegetation in the base year				

Abbreviation: NO = not occurring.
[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustment(s).
[b] "Final" includes revised estimates, if any, and/or adjustments, if any.
[c] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Table 12
Information to be included in the compilation and accounting database in t CO_2 eq for 2009

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Annex A emissions for 2009				
CO_2	10 704 662			10 704 662
CH_4	444 886			444 886
N_2O	467 681			467 681
HFCs	65 540			65 540
PFCs	218			218
SF_6	6 999			6 999
Total Annex A sources	**11 689 986**			**11 689 986**
Activities under Article 3, paragraph 3, for 2009				
3.3 Afforestation and reforestation on non-harvested land for 2009	–77 996			–77 996
3.3 Afforestation and reforestation on harvested land for 2009	NO			NO
3.3 Deforestation for 2009	141 380			141 380
Activities under Article 3, paragraph 4, for 2009[c]				
3.4 Forest management for 2009				
3.4 Cropland management for 2009				
3.4 Cropland management for the base year				
3.4 Grazing land management for 2009				
3.4 Grazing land management for the base year				
3.4 Revegetation for 2009				
3.4 Revegetation in the base year				

Abbreviation: NO = not occurring.
[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustment(s).
[b] "Final" includes revised estimates, if any, and/or adjustments, if any.
[c] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Table 13
Information to be included in the compilation and accounting database in t CO_2 eq for 2008

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Annex A emissions for 2008				
CO_2	11 209 103			11 209 103
CH_4	444 813			444 813
N_2O	463 406			463 406
HFCs	63 460			63 460
PFCs	242			242
SF_6	6 571			6 571
Total Annex A sources	**12 187 595**			**12 187 595**
Activities under Article 3, paragraph 3, for 2008				
3.3 Afforestation and reforestation on non-harvested land for 2008	–76 513			–76 513
3.3 Afforestation and reforestation on harvested land for 2008	NO			NO
3.3 Deforestation for 2008	141 049			141 049
Activities under Article 3, paragraph 4, for 2008[c]				
3.4 Forest management for 2008				
3.4 Cropland management for 2008				
3.4 Cropland management for the base year				
3.4 Grazing land management for 2008				
3.4 Grazing land management for the base year				
3.4 Revegetation for 2008				
3.4 Revegetation in the base year				

Abbreviation: NO = not occurring.

[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustment(s).

[b] "Final" includes revised estimates, if any, and/or adjustments, if any.

[c] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Annex II

Documents and information used during the review

A. Reference documents

Intergovernmental Panel on Climate Change. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>.

Intergovernmental Panel on Climate Change. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/gp/english/>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Available at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

"Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories". FCCC/SBSTA/2006/9. Available at <http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf>.

"Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention". FCCC/CP/2002/8. Available at <http://unfccc.int/resource/docs/cop8/08.pdf>.

"Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol". Decision 19/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=14>.

"Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol". Decision 15/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=54>.

"Guidelines for review under Article 8 of the Kyoto Protocol". Decision 22/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=51>.

Status report for Luxembourg 2013. Available at <http://unfccc.int/resource/docs/2013/asr/lux.pdf>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2013. Available at <http://unfccc.int/resource/webdocs/sai/2013.pdf>.

FCCC/ARR/2012/LUX. Report of the individual review of the annual submission of Luxembourg submitted in 2012. Available at <http://unfccc.int/resource/docs/2013/arr/lux.pdf>.

UNFCCC. *Standard Independent Assessment Report*, parts I and II. Available at <http://unfccc.int/kyoto_protocol/registry_systems/independent_assessment_reports/items/4061.php>.

B. Additional information provided by the Party

Responses to questions during the review were received from Dr. Marc Schuman (AEV), including additional material on the methodologies and assumptions used. The following documents[1] were also provided by Luxembourg:

Steinlechner E, *et al. Möglichkeiten er Vermeidung und Nutzung Anthropogener* Methanemissionen (Possibilities for the Prevention and Use of Anthropogenic Methane Emissions). Report of the Institute für Umweltgeolgoie und Ökosystemforschung.

Wilfried Winiwarter, Traute Kötter and Marc Schuman *Uncertainty of Luxembourg's Greenhouse Gas Inventory Report to support national reporting obligations to UNFCCC – Update 2011* AIT-F&PD-Report, Vol. 53, December 2011 (limited distribution).

[1] Reproduced as received from the Party.

Annex III

Acronyms and abbreviations

AD	activity data
C	carbon
CH_4	methane
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
CRF	common reporting format
CSEUR	Consolidated System of European Union Registries
EF	emission factor
ERT	expert review team
EU	European Union
EU ETS	EU emissions trading system
F-gases	fluorinated gases
FAO	Food and Agriculture Organization of the United Nations
GHG	greenhouse gas; unless indicated otherwise, GHG emissions are the sum of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 without GHG emissions and removals from LULUCF
ha	hectare
HFCs	hydrofluorocarbons
IE	included elsewhere
IEA	International Energy Agency
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
ITL	international transaction log
kg	kilogram (1 kg = 1,000 grams)
kha	kilohectare
KP-LULUCF	land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol
LULUCF	land use, land-use change and forestry
m^3	cubic metre
MBT	mechanical-biological treatment
MCF	methane conversion factor
Mg	megagram (1 Mg = 1 tonne)
N	nitrogen
N_2O	nitrous oxide
NA	not applicable
NE	not estimated
NFI	national forest inventory
Nex	nitrogen excretion rate
NIR	national inventory report
NO	not occurring
PFCs	perfluorocarbons
QA/QC	quality assurance/quality control
SEF	standard electronic format
SF_6	sulphur hexafluoride
SIAR	standard independent assessment report
SWDS	solid waste disposal sites
t	tonne

TJ	terajoule (1 TJ = 10^{12} joule)
UNFCCC	United Nations Framework Convention on Climate Change